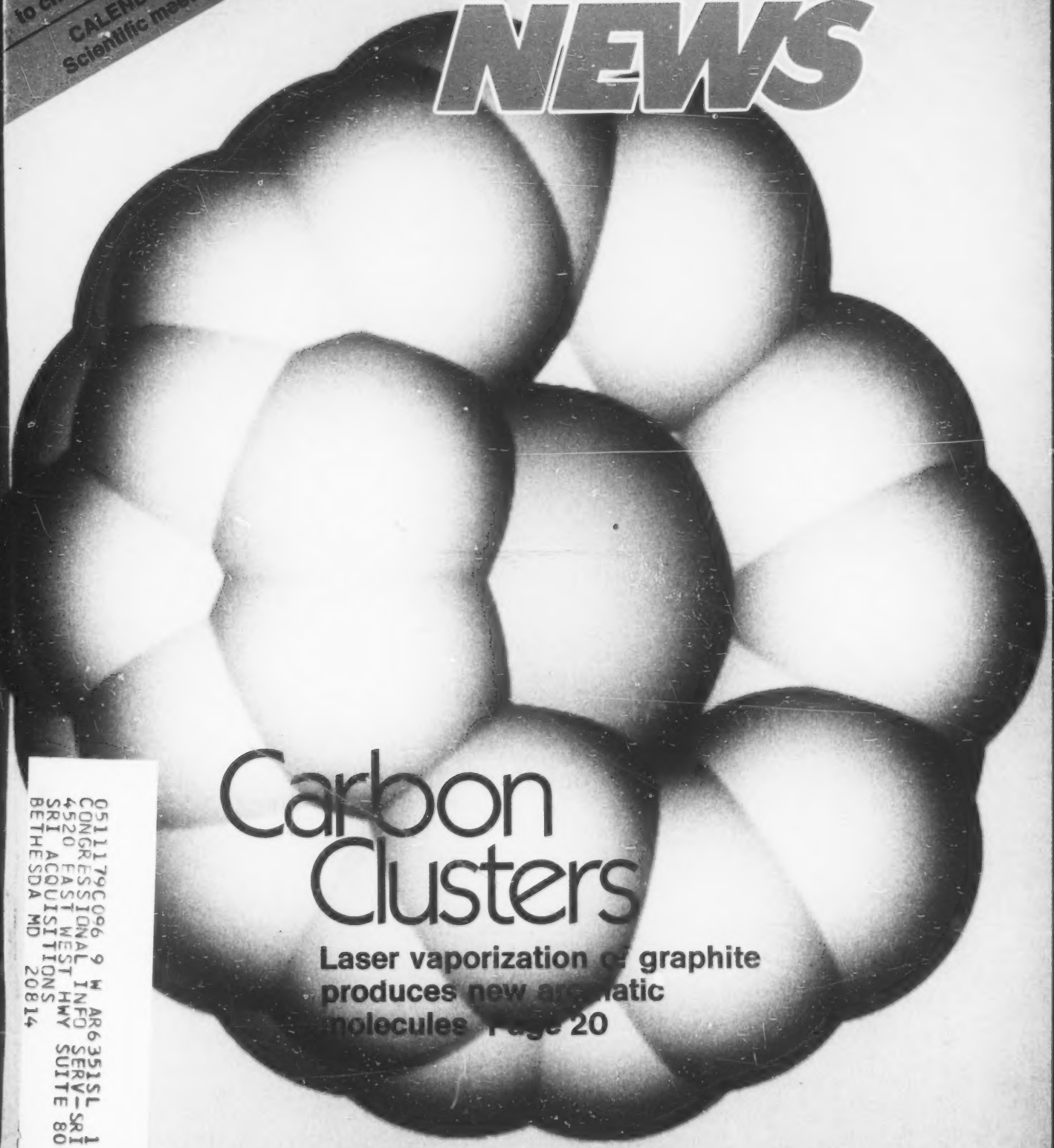
A1250-1

DECEMBER 23, 1985
CHEMICAL & ENGINEERING

NEWS

Chemical capital spending to change little in 1986 Page 10

CALENDAR OF EVENTS
Scientific meetings Page 34



Carbon Clusters

Laser vaporization of graphite produces new aromatic molecules Page 20

05111790096 9 W AR6351SL 1
CONGRESSIONAL INFO SERV-SRI
4520 EAST WEST HWY SUITE 800
SRI ACQUISITIONS
BETHESDA MD 20814

CHEMICAL & ENGINEERING
NEWS

Volume 63, Number 51
CENEAR 63 (51) 1–52
ISSN 0009-2347

DECEMBER 23, 1985

News of the Week

■ **EPA releases its Chemical Emergency Preparedness Plan for local governments.** **Page 3**

■ **OTA study points up uncertainties in estimating risk to reproductive health in the workplace.** **Page 4**

■ **Congress okays funds to produce binary artillery shells.** **Page 4**

■ **Du Pont chemist is accused of making, selling designer drug.** **Page 5**

■ **Occidental Chemical celebrates holidays with sound and light show.** **Page 5**

■ **Union Carbide fights the takeover attempt by GAF.** **Page 6**

■ **Eli Lilly ups the ante in its bid to buy Hybritech.** **Page 6**

Cover: Possible structure of an aromatic carbon "eggshell" complex of a central metal atom. This particular computer-generated image shows one possible form of a C_{48} carbon shell. Photo courtesy of J. C. Spurlino and F. A. Quiocho, biochemistry department, Rice University

Letters 2

Concentrates

Business 9
Government 15
Science/Technology 19

The Departments

ACS Comment 31
Newscripts 52

Business

U.S. chemical companies' capital spending will increase only 2.3% on average in 1986, less than forecast inflation rate. **Page 10**

Many biotechnology-based firms increased revenues in third-quarter 1985, moving more products to market. **Page 12**

Plastics consumption in the U.S. will reach more than 47 billion lb this year, an almost 5% increase over 1984. **Page 14**

Government

Keyworth steps down from post of Presidential science adviser to start firm of consultants for multinational companies. **Page 16**

Technology

Highlighted at Chem Show, Allied-Signal's Aquatech water-splitting technique is ready for commercialization. **Page 23**

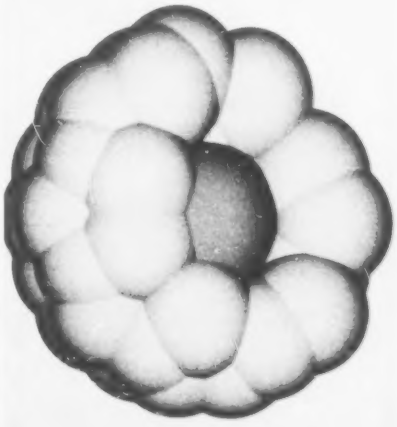
Producing oxygen-enriched air for uses such as portland cement making, chemical processes aim of Dow Generon systems. **Page 26**

People

The late Paul J. Flory, Nobelist, polymer scientist, educator, author, and fighter for human rights, eulogized by his colleagues. **Page 27**

Meetings

C&EN's semiannual calendar of meetings and events lists those of interest to chemists and chemical engineers. **Page 34**



Science

New aromatic molecules from laser vaporization of graphite include stable 60-carbon cluster that is thought to have form of truncated icosahedron. **Page 20**

Chemical Capital Spending To Gain Little in 1986

Expenditures by major U.S. chemical firms will rise less than 3% next year; outlays this year were up an estimated 6% over 1984

William J. Storck, C&EN New York

Economists across the country are forecasting that general capital spending next year will show little, if any, gain from this year's levels, and that will do little to help economic expansion next year. They point to healthy growth in spending on new plant and equipment in the past two years as one of the reasons that the economy has performed well.

That same lackluster forecast for next year is repeated in the results of a recent C&EN survey of capital spending plans by chemical companies, which shows about the same level of capital expenditures in the industry next year as this year. However, the chemical economy differs from the general economy in at least one major way: Chemical capital spending did not have the post-recessionary spurt that many other industries had in the past couple of years.

C&EN's survey found that 13 chemical producers intend to increase capital spending less than 3% on average next year over 1985 levels. That probably will represent a lowering of real investment, because the rise will be less than inflation, now forecast at about 3.5%. The 2.3% increase for next year follows an estimated 6% rise in 1985 over 1984 capital spending for the same companies.

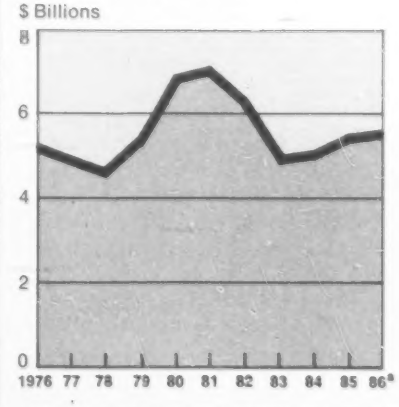
The chemical industry has had few incentives in recent years for capital spending and, indeed, quite a few disincentives. Chief among these is the capacity utilization rate among chemical makers. In the third quarter, the Federal Reserve Board estimated capacity utilization for chemicals and products at a seasonally adjusted 78.5%, well below the levels needed for additional plant. And for basic chemicals, the capacity use rate is probably even lower. The capacity use rate has been cut by a number of factors including slow demand for many products in the U.S., a heady amount of foreign imports into the U.S., and a low level of exports, which have to compete with cheaper foreign goods in markets outside the U.S.

In addition, the long-standing relationship between capital spending and interest rates is still continuing, though not as strongly as it was a year ago. In the past few years, chemical prices have been depressed, keeping rates of return from chemical plants below the cost of capital to build new plant. Because interest rates have fallen in the past year, this situation is not as bad as it was, but is still bad enough to put the brakes on capital spending, except for firms that make higher-value-added products.

The slow pace of reinvestment in the chemical industry is causing some concern that many segments of the industry, if they do not begin to build new plants soon, won't be able to compete with imports. Perhaps basic commodity chemicals will become much like the steel industry.

The reasoning works like this: Since it takes two to three years to build a chemical plant, with the current low level of spending, no plants will be completed in the immediate future. If, then, either domestic or export demand increases, U.S. chemical plants may be hard pressed to serve that increase, and foreign imports will have to fill the gap. Further, newer and perhaps more efficient plants being built near lower-cost feedstocks could make imported products cheap enough in the long run compared with U.S.

Chemical capital spending will rise slightly in 1986 . . .



. . . but will drop as a percentage of sales

a C&EN estimate. **Note:** Combined data from 13 major chemical producers.

Capital spending will rise average of 2.3% next year for 13 chemical companies

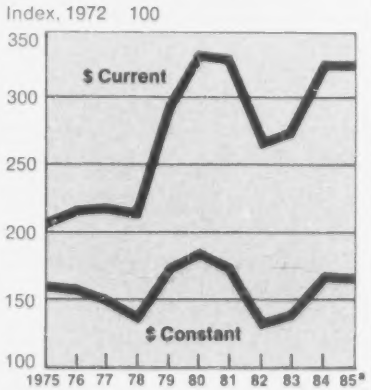
$ Millions	1986 Total	1986 U.S.	1985 Total	1985 U.S.	Worldwide 1985 planned[a]	Worldwide 1984	Worldwide 1983	Worldwide 1982	Worldwide 1981	Change from previous year 1986	Change from previous year 1985
Air Products	$ 402	$ 317	$ 402	$ 317	$ 325	$ 263	$ 246	$ 347	$ 323	0.0	52.9%
American Cyanamid	200	160	200	160	200	200	165	171	181	0.0	0.0
Celanese	200	185	170	155	200	169	105	275	414	17.6%	0.6
Dow Chemical	900	540	830	498	830	781	630	829	1176	8.4	6.3
Du Pont[b]	1205[c]	na	1180[c]	na	1700	1138	1276	1300	1420	2.1	3.4
Ethyl	135	133	80	78	116	103	85	92	141	68.8	−22.3
W. R. Grace	390	321	450	384	420	380	353	560	657	−13.3	18.4
Hercules	215	161	205	154	210	218	168	174	167	4.9	−6.0
Monsanto	525	473	575	516	575	614	560	673	668	−8.7	−6.4
Olin	110	108	110	108	170	165	123	139	186	0.0	−33.3
PPG Industries	410	349	400	340	400	315	450	452	376	2.5	27.0
Rohm & Haas	200	160	165	132	130	134	72	126	182	21.2	23.1
Union Carbide	670	455	670	455	650	670	761	1179	1186	0.0	0.0
TOTAL	**$5562**	**$3362**	**$5437**	**$3297**	**$5926**	**$5150**	**$4994**	**$6317**	**$7077**		
ANNUAL CHANGE[d]	**2.3%**	**2.0%**	**5.6%**	**3.3%**	**13.6%**	**3.1%**	**−20.9%**	**−10.8%**	**2.4%**		

a Earliest estimates. b Excludes Conoco. c C&EN estimates. d Cumulative change for companies reporting. na = not available.

chemicals produced in aging plants that the imports ultimately may hold sway.

The 5.6% rise in capital spending in 1985 reflects the realities of the marketplace. Earlier this year chemical companies were predicting that capital spending in 1985 would be almost 14% above what it was in 1984. The chemical economy, however, obviously caused moderation. The meager 2.3% rise for next year seems to indicate that chemical company executives continue to believe that demand over the next few years will warrant very little new plant building.

Capital appropriations remained level in 1985



a C&EN estimate. **Source:** Conference Board

Among the 13 companies surveyed, the largest hike in 1985 spending was by Air Products, whose capital spending increased nearly 53% from 1984 to $402 million. That was followed by a 27% increase by PPG Industries to $400 million and a 23% rise by Rohm & Haas to $165 million. The next highest increase was by W. R. Grace, whose capital spending in 1985 is expected to total $450 million, up 18% from 1984. Other increases this year include 6.3% by Dow Chemical to $830 million, 3.4% by Du Pont (excluding its Conoco operations) to $1.2 billion, and 0.6% by Celanese to $170 million.

Two companies—Union Carbide and American Cyanamid—have managed to hold their own this year with no change, with spending of $670 million by Carbide and $200 million by Cyanamid.

Four companies in the survey decreased capital spending in 1985. For Hercules, spending is down 6% to $205 million; Monsanto, 6.4% to $575 million; Ethyl, 22% to $80 million; and Olin, 33% to $110 million.

For 1986, the few companies that are predicting large increases say that the gains are mainly for projects that were deferred from this year. For instance, Ethyl says that its spending, although down 22% in 1985, will increase 69% in 1986 to $135 million. Celanese is projecting an 18% rise to $200 million, following its 0.6% increase this year. Only Rohm & Haas is following a good year with another good year, forecasting that capital spending will rise 21% in 1986, after its 23% rise in 1985.

Dow is projecting that its capital expenditures next year will rise 8.4% to $900 million. Hercules' spending will be up 5% to $215 million, and PPG Industries' will increase 2.5% to $410 million. Du Pont, excluding Conoco, plans to boost its capital spending an estimated 2.1% to $1.21 billion.

Four companies—Air Products, American Cyanamid, Olin, and Carbide—will hold capital spending to 1985's levels. And only two are projecting declines next year: Monsanto says spending will be down 9% to $525 million, and W. R. Grace says its will be down 13% to $390 million.

However, no matter what the forecast is at this time, it is sure to change as market conditions and chemical executives' perceptions of the economy change. A year ago, combined 1985 capital spending by the 13 companies was forecast to be up nearly 17% to almost $6.1 billion. Instead, capital spending this year came in only 5.6% higher at $5.43 billion, more than 10% below the original projection. □

Most biotechnology firms score gains in third quarter

David Webber, C&EN New York

During the third quarter, the best-known biotechnology-based companies moved more products to market, expanded and, in some cases, improved their relationships with larger corporations, and continued to wrestle products through the regulatory process. For many firms, revenues swelled hugely, either because of greater product sales or large, initial collaborative R&D payments. And at others, mounting costs of clinical trials, though a reflection of progress in bringing therapeutic products closer to commercialization, resulted in further losses.

One of the most solid performers in the third quarter was Monoclonal Antibodies, Mountain View, Calif., which reported the first quarterly net income in its history. Its small profit of $122,265 was achieved through a 134% increase in revenues compared with the same period in 1984. Most of that jump came in the marketplace, where the company boosted sales of its antibody-based diagnostic kits 119% from third-quarter 1984. Sales were also up 42% compared with second-quarter 1985 and amounted to 74% of all revenues. Further elevating figures was a one-time payment of $400,000 due to the restructuring of a relationship with Ralston Purina that helped nearly triple contract revenues for the quarter.

In addition, the quarter results probably included the last major expenses related to the company's successful defense of a patent infringement lawsuit brought against it by Hybritech. Monoclonal Antibodies won the suit in August, but still had $355,000 in legal costs in the quarter. Despite a notice of appeal by Hybritech, Monoclonal Antibodies believes the burden of the suit is now essentially behind it.

Amgen, Thousand Oaks, Calif., also reported a big jump in revenues—in this case 195%, compared with third-quarter 1984—but the improvement was due entirely to massive initial payments by Johnson & Johnson as part of a joint venture arrangement in erythropoietin, hepatitis B vaccine, and interleukin-2. The payments raised Amgen's R&D revenues, which account for 91% of all revenues, 368%, making it possible for the company to report net income for the quarter of $2.3 million, compared to a third-quarter 1984 loss of $2.0 million.

Laster: close to break-even point

For BioTechnica International, Cambridge, Mass., revenues surged 332% in the third quarter, thanks to a larger component of contract fees in the revenue mix based on the expansion of several existing contracts and the initiation of some new ones. The climb in revenues brought the company's third-quarter loss down 26%. Over the first nine months of 1985, BioTechnica lost $2.2 million, 30% less than in the equivalent 1984 period.

"These financial results clearly underscore the positive trend toward a breakeven position on an annualized basis as of the final quarter of 1985," says John C. Hunt, chief executive officer. "Beginning in 1986, we will take the next strategic step in BioTechnica's development plan, which will consist of the expansion of the company's product base. Product sales should decrease our dependence on contract research as a percentage of total revenues in the coming year and contribute to our goal of achieving profitable operations in 1986."

Continuing to perform like the Cadillac to which it is often likened, Genentech, South San Francisco, Calif., went through the third quarter in stately fashion, raising net income 47% to $1.6 million on a 16% increase in revenues. As in previous quarters, about 90% of those revenues came from contract fees, but Genentech now has a product on the market in Protropin, its human growth hormone that was approved by the Food & Drug Administration in October. The firm already is receiving royalties on sales of Protropin in Europe from Kabi Vitrum, the Swedish firm that owns manufacturing and marketing rights for the product outside the U.S.

At Biogen, Cambridge, Mass., revenues shrank 30%, owing to a 31% decline in R&D fees and a 28% drop in interest income. At the same time, although overall expenses were less than in the same quarter a year earlier, some costs rose because of continued Phase III clinical trials of Biogen's gamma interferon for use against kidney cancer and other tests of the substance in treating rheumatoid arthritis. As a result, the company's third-quarter loss ballooned to $4.8 million, compared with $2.8 million in third-quarter 1984. Over the first nine months of the year, Biogen lost $12.6 million compared with $10.9 million during the comparable 1984 period.

Centocor, Malvern, Pa., the leading monoclonal antibody-based company now that Hybritech has been acquired by Eli Lilly, added to its record of strong quarterly growth. Third-quarter revenues jumped 60% to $5.6 million, swelling earnings 299% to just under $1 million. For the nine-month period, Centocor's earnings were up 515% on a revenue increase of 76%.

Centocor has been one of the chief beneficiaries of the acquisition of Hybritech and that of Genetic Systems by Bristol-Myers. Stock market investors reacted to the high prices paid for those two producers of diagnostics based on hybridoma technology by buying into Centocor. As a result, the price of Centocor common stock has shot up 49% since

Revenues surged at some biotechnology companies

	THIRD-QUARTER 1985[a]						NINE MONTHS 1985[a]					
	Revenues[b] ($ millions)	Earnings[c] ($ millions)	Change from 1984 Revenues	Change from 1984 Earnings	Profit margin[d] 1985	Profit margin[d] 1984	Revenues[b] ($ millions)	Earnings[c] ($ millions)	Change from 1984 Revenues	Change from 1984 Earnings	Profit margin[d] 1985	Profit margin[d] 1984
Amgen	$ 7.523	$ 2.293	195%	def	30.5%	def	$14.210	$ −1.460	129%	def	def	def
Biogen	5.701	−4.829	−30	def	def	def	17.251	−12.589	−22	def	def	def
Bio-Response	0.923	−0.727	254	def	def	def	2.600	−2.347	267	def	def	def
BioTechnica International	1.340	−0.790	332	def	def	def	3.591	−2.224	261	def	def	def
Bio-Technology General	0.431	−0.641	121	def	def	def	1.191	−2.097	45	def	def	def
California Biotechnology	2.471	−0.157	21	def	def	def	6.833	−0.218	12	def	def	0.0%
Centocor	5.605	0.942	60	299%	13.8	6.7%	15.425	2.241	76	515%	12.0%	3.4
Cetus	9.051	0.108	−56	−71	1.2	1.6	32.449	0.853	−30	0	2.6	1.8
Damon Biotech	0.970	−2.755	−6	def	def	def	2.569	−8.364	−35	def	def	def
DNA Plant Technology	1.182	−0.157	24	def	def	def	3.196	−0.407	33	def	def	def
Genentech	22.153	1.609	16	47	7.3	5.8	63.729	3.425	23	62	5.4	4.1
Genex	4.600	−2.200	−62	def	def	30.6	14.195	−6.800	−44	def	def	def
Immunex	1.041	−0.866	44	def	def	def	2.351	−3.330	15	def	def	def
Molecular Genetics	1.851	−0.559	−19	def	def	2.3	6.092	−1.772	−14	def	def	0.1
Monoclonal Antibodies	2.600	0.122	134	def	4.7	def	5.917	−0.872	111	def	def	def

a For three-month or nine-month period ending closest to Sept. 30. b Includes sales, contract research, royalty, and interest revenues. c Excludes extraordinary credits. d After-tax income as a percentage of sales. def = deficit.

the beginning of September. Seeking to capitalize on that, Centocor last week announced a public offering of 1 million new shares of common stock, a rare event among biotechnology-based companies over the past two years.

At DNA Plant Technology, Cinnaminson, N.J., third-quarter revenues rose 24% compared to the same period a year earlier, and the quarter's net loss shrank to $157,000 from $180,000 in third-quarter 1984. Over the first nine months of the year, revenues were up 33%. Nine-month losses declined 39% to $407,000.

"Our annual rate of revenue from research and product development activities is now above $4 million and exceeds the previously projected level," comments Richard Laster, president and chief executive officer. "While amply supporting our research and product development activities, we continue to be able to operate the company close to breakeven."

Damon Biotech, a contract cell culture company in Needham Heights, Mass., derived all of its third-quarter noninterest revenues from sales of monoclonal antibodies. Sales of these antibodies climbed 220% to $628,000. But because of far lower interest income, total revenues in the company's fiscal fourth quarter, which ended Aug. 31, shrank 6% to $970,274. At the same time, costs and expenses jumped 29%, resulting in a net loss before an extraordinary tax gain of $2.8 million, which is 49% higher than in the same period in 1984.

Third-quarter declines also were reported by Molecular Genetics, Minnetonka, Minn., whose 19% drop in revenues combined with an 8% jump in expenses led to a loss of $558,850, compared to a tiny third-quarter 1984 profit. The company is still struggling to boost sales of its animal health products, which over the first nine months of the year have brought in only 8% more than in the equivalent 1984 period. Molecular Genetics has made changes in its marketing tactics that it hopes will improve sales.

For Genex, Rockville, Md.—now in the midst of a drastic retrenchment—the third quarter marked the final revenues from sales of L-phenylalanine (an aspartame ingredient) to G. D. Searle (now a unit of Monsanto). Searle told Genex last spring that it would stop buying the product after Oct. 1. Because of the end of that vital sales contract, Genex has been forced to shut down the Paducah, Ky., plant into which the company had poured much of its assets. The Paducah employees lost their jobs at the end of October, and some 40% of the staff in the company's headquarters facilities were laid off this month.

In the third quarter, Genex's revenues from product sales dropped—as a result of both the tapering off of Searle's purchases and lower prices—to $4.0 million from $10.7 million in the same quarter a year earlier. Overall, revenues were down 62% in the quarter. As a result, the firm lost $2.2 million in the third quarter, after earning $3.7 million in the equivalent 1984 period. Over nine months, Genex revenues plunged 44% to $14.2 million. The 1985 nine-month net loss was $6.9 million, compared to a marginal profit for the same span in 1984.

Genex now has decided to continue as a contract R&D operation, with the exception of a small effort to market enzyme-based cleaning products. As a result of this return to a smaller scale, three members of senior management resigned at the end of November. In an attempt to recoup its losses, the firm sued Searle in October, alleging that Searle induced Genex by fraudulent misrepresentation to rush L-phenylalanine into production (C&EN, Oct. 21, page 14). The suit, filed in federal district court in Baltimore, seeks at least $40 million in compensatory damages plus punitive damages as well as treble damages under antitrust and antiracketeering laws. □

Plastics consumption to top 47 billion lb in 1985

Sales and captive use of plastics in the U.S. will hit a record 47.4 billion lb this year, up nearly 5% from 1984, according to Charles E. O'Connell, president of the Society of the Plastics Industry (C&EN, Dec. 16, page 8). But growth in 1986 will slow to 2%, he adds, because of declining auto sales and housing starts, plus rising imports, which now comprise 4% of U.S. plastics consumption.

Of 1985 consumption, O'Connell estimates that almost 13 billion lb (27%) will go into packaging, nearly 12 billion lb (25%) for building and construction, 4 billion lb (9%) for consumer and institutional products, 3 billion lb (6%) for electrical and electronic parts, 2.4 billion lb (5%) for transportation uses, 2 billion lb (4%) for furniture and furnishings, 2 billion lb (4%) for inks and coatings, 5 billion lb (10%) for other uses, and 5 billion lb (10%) for exports.

The SPI president cautions that such end uses are difficult to estimate this year. This is because of uncertainty in economic performances of individual markets, competition among plastics for many end uses, and a growing amount of "other uses" that includes sales to distributors and compounders who do not report end uses to SPI. In particular, he says, polypropylene and polystyrene are moving into applications previously served by engineering resins.

Among major resins, O'Connell predicts that use of low-density polyethylene will be up 6.9% this year over 1984 to 9 billion lb, high-density polyethylene up 9.2% to 6.5 billion lb, polypropylene up 8% to 5.2 billion lb, and polystyrene up 4.3% to 4 billion lb. His estimates for these and other resins are based on reporting through September of SPI member firms to the accounting firm of Ernst & Whinney.

Polyvinyl chloride use, however, will decrease 1.1% to 6.7 billion lb. This is still a turnaround for PVC, demand for which was falling at the rate of 6% per year in June. O'Connell attributes the ailing PVC market to growing imports of resin and finished goods.

As for engineering resins, they suffer not only from competition from polypropylene and polystyrene but from slowed growth in their largest outlet, electrical and electronic parts. In addition, O'Connell says, the electrical and electronic industries may be shifting to foreign sources of such parts. Still, engineering resins use will be up 3.7% this year to almost 1 billion lb.

The fastest-growing outlet for plastics is building and construction, he says. Growth this year was spearheaded by pipe and conduit, plumbing fixtures, siding, windows and doors, and thermal insulation. Building and construction is also the market in which plastics have the greatest opportunities to continue to replace other materials.

O'Connell ascribes the healthy growth of plastics packaging itself to consumers' increased acceptance of plastics for self-service merchandising, convenience, and safety. He notes that use of thermoplastic polyester, which is the prime material in the rapidly growing beverage container market, has slowed in growth but still will post a 7.7% increase in 1985 to almost 1 billion lb. In addition to thermoplastic polyester, HDPE also accounts for exceptional growth in rigid containers.

The 5 billion lb of resins exports this year amounts to a 12% rise over 1984. Polyolefins are almost entirely responsible for this rise as their exports increased 700 million lb this year. But O'Connell warns that imports are on the rise as well. Although total imports average only 4% of U.S. plastics consumption, the share is already 10% for styrene-acrylonitrile resins, nylons, and polyvinyl alcohol. The warning signs also are out for LDPE, PVC, and acrylonitrile-butadiene-styrene resins, he says, for which imports are 6% of consumption. Continued increases in imports are likely, because of a U.S. political climate that favors free trade. He cites such Western Hemisphere countries as Canada, Mexico, and Brazil as chief sources of plastics imports. □

U.S. plastics sales and captive use will be up nearly 5%

Millions of lb	1985 production[a]	% change 1984–85	1985 sales and captive use[a]	% change 1984–85
THERMOSETTING RESINS	**5,665**	**2.1%**	**5,650**	**2.6%**
Phenolic	2,630	5.1	2,640	5.2
Urea	1,240	3.4	1,235	3.9
Polyester, unsaturated	1,230	−0.2	1,230	−0.1
Epoxy	385	−5.2	365	−3.7
Melamine	180	−14.3	180	−8.6
THERMOPLASTIC RESINS	**35,000**	**2.7**	**35,860**	**4.7**
Low-density polyethylene	8,750	4.0	9,000	6.9
Polyvinyl chloride	6,750	−0.1	6,725	−1.1
High-density polyethylene	6,550	7.6	6,500	9.2
Polypropylene	5,075	2.7	5,200	8.0
Polystyrene	3,975	3.6	4,000	4.3
Acrylonitrile-butadiene-styrene	1,000	−11.3	1,000	−8.9
Styrene-acrylonitrile	90	−9.1	85	−3.4
Other styrene-based polymers	270	6.3	270	15.9
Styrene-butadiene latex & other styrene-based latexes	710	−4.7	750	0.1
Thermoplastic polyester	950	5.7	925	7.7
Vinyl acetate	675	−2.2	675	−2.2
Polyvinyl alcohol	145	5.1	140	0.7
Other vinyls	185	−1.1	190	1.6
Nylon	375	−5.3	400	2.8
ENGINEERING RESINS	**925**	**5.4**	**925**	**3.7**
OTHERS[b]	**5,600**	**5.0**	**4,950**	**8.2**
TOTAL	**47,190**	**2.9%**	**47,385**	**4.8%**

a Estimates based on data reported through September. b Including polyurethane.
Source: Society of the Plastics Industry